and digging new canals for deviating rivers, etc., but these works are far more formidable in Panama than on the Isthmus of Nicaragua. The control of the Chagres River has been one of the most serious obstacles to successfully carrying on the work at Panama. On the route selected for the Nicaragua Canal by the surveying party of 1885, obstacles of a similar kind would have been encountered in the basin of the Rio Grande between Lake Nicaragua and Brito; but in the new plan of 1888 this difficulty has been overcome by damming up the river, and transforming its valley into an artificial lake, the Tola basin.

On the profile of the Panama Canal may be seen both the volumes to be excavated for the purpose of establishing a lock-canal and a sea-level canal. The number of locks necessary for the former is ten, while the plan of the Nicaragua Canal contemplates only six locks. A single glance shows that by far the greater amount of work necessary to complete a sea-level canal remains to be done, and that comparatively little has been accomplished in the most difficult sections of the canal. While it seems impossible to complete the deep Culebra cut on account of the movements of the soil, no such difficulties are anticipated in the short deep cut of the Nicaragua Canal crossing the eastern divide. Careful borings have shown the soundness of the rock.

If we consider that the Nicaragua Canal Company is just starting its work, while the Panama Canal Company is burdened with an enormous debt; that the amount of work left to be done is smaller in Nicaragua than in Panama, — we must regard the prospects of the former as very encouraging.

The profile of the Panama Canal shows, on the other hand, the amount of work done as compared to that left unfinished. Much money has been expended; and the interests at stake are so powerful, that we do not believe the work will be dropped, but will be pursued in some way or other. A decrease of the working force seems to be, however, at present unavoidable, and this will relieve the Nicaragua Canal Company of another difficulty, the scarcity of workingmen in these tropical regions. If the work on the latter is undertaken without unnecessary delay, and if it is continued as carefully as the preliminary surveys warrant it will be, we expect to see it completed at an early day. The Panama Canal, even if opened at a later day, will have to contend against an established route, run at smaller expense than its own, as the capital invested and the number of locks, which cause increased expense, will be smaller.

THE SPRAGUE ELECTRIC ROAD AT BOSTON.

WE take pleasure in presenting our readers in this issue of our paper with a general view of the new electric street-railway between Boston and Brookline, installed by the Sprague Electric Railway and Motor Company of New York. There have been several trial trips made over this railway already, to test the apparatus, which has been found to be perfect, and the road will be put into commercial operation in a few days.

The West End Street Railway of Boston, of which this road is a part, is the largest street-railway in the world. It extends over 212 miles of track, using 1,700 cars and more than 9,000 horses. The president of the West End Street Railway Company, Mr. Henry M. Whitney of Boston, is universally recognized as being one of the most enterprising and successful street-railway men in the country, and, aided by an efficient corps of assistants, has succeeded in giving Boston since his administration the most efficient street-railway service which ever existed in that city.

Before deciding upon any electric system to be adopted upon the West End Road, President Whitney, accompanied by members of the board of directors and managers, visited all the principal electric railways in the country operated upon the various systems, including visits upon three different occasions to Richmond, Va., to inspect the famous electric road in operation there upon the Sprague system. After a most careful examination of all these different roads, the contract for equipping the West End Road was awarded by the board of directors to the Sprague Electric Railway and Motor Company of New York.

This system of electric railway called for in this contract is wide and comprehensive. The main line from Boston westward, beginning at Park Square, will run down Boylston Street bridge, and then down Chester Park to Beacon Street. It will then proceed over the Beacon Street extension to the Chestnut Hill Reservoir, and to Allston, and Oak Square, Brighton. From the East Park gate, over the new boulevard to the Chestnut Hill Reservoir and Brighton, the Sprague overhead system will be adopted; in the more crowded streets of the city the Bentley-Knight conduit will be used; and the Sprague cars will run over the whole system.

The power-station from which the electric current is distributed to the line is situated on Braintree Street, Allston, near the Boston and Albany Railroad, and also at the edge of the water, thus giving both water and rail facilities for fuel. This building, which is the most perfect electric plant of its kind in the country, is situated very nearly equidistant from the extremities, and is therefore literally a central station. The station, with the adjoining car-house, is of brick, and completely fire-proof.

In its construction it was the aim of the West End Company to get the best in every detail. The chimney-stack is 100 feet high. The boiler-house, which is both convenient and commodious, is at present equipped with three horizontal tubular boilers, furnished by the Jarvis Engineering Company. The engine-room contains two high-speed automatic cut-off engines of the Armington & Sims pattern, of 200 horse-power each. Each drives two powerful dynamos of 80,000 watts each, and wound for a maximum pressure of 500 volts. These dynamos are of the highest efficiency and simplest construction, and, if need be, can be placed under the charge of the steam-engineer. The dynamos feed into copper bus wires, supported on the walls by porcelain insulators.

Each machine has its independent ampère meter, and in addition there is a general ampère meter at the end of the positive bus bar. From this bar the current passes to special snap-switches, each switch being connected through a three-plug safety-switch back to one of the feeders supplying current to the main line-wire. These feeder-wires tap into the line-wire at different points on the line of road, thus maintaining the pressure approximately equal all along the line. At the ends of the feeders in the central station, pressure-indicators are attached, which indicate the voltage at the junctions of the feeders with the main current-wire.

The engine-room is brilliantly lighted by handsome hanging electroliers, each of which has five incandescent lamps. A switch-board at one end of the room furnishes an independent control for each group of lamps. All the surroundings of the machines are kept in the neatest condition.

Adjoining the power-house, but separated by thick brick walls, is a commodious house for accommodation of cars, 107 feet long by 80 feet deep, designed to hold 24 cars.

The overhead system, which is built under the Sprague patents, is of the finest description, and includes iron poles set in concrete throughout the entire length of the road. These poles are of a very neat and tasteful pattern, and support the span-wires which carry the trolley-wire at a height of 18 feet over the centre of the track. This overhead wire, which is used for a working conductor, is made of silicon bronze, of the small Sprague type, only three-sixteenths of an inch in diameter. This is the only wire suspended over the middle of the track, and its lightness and high tensile strength allow the overhead supporting structure to be of the lightest description possible. The poles are 125 feet apart.

The return circuit is through the rail, and thence by both metallic and ground circuits to the station. Each section of rail is joined to copper ground wires throughout the length of the road underneath the string-pieces. At intervals of 500 feet this ground wire is connected to an earth plate, and at seven points widely distributed. The ground wire is connected to the station, and there is also a main ground connection made there through a large sink-plate.

In the overhead system a new method of switching has been adopted, which is at once ingenious and simple. Five or six feet inside the turnouts a small switch with flaring rider is interpolated into the main and branch wires, and a spring tongue upon this directs the path of the trolley with absolute certainty and ease. By this means, switching is made very easy, and all danger of the trolley leaving the wire is obviated.

The cars can be run at widely different speeds, varying from the slowest crawl to twelve or more miles per hour. They can be

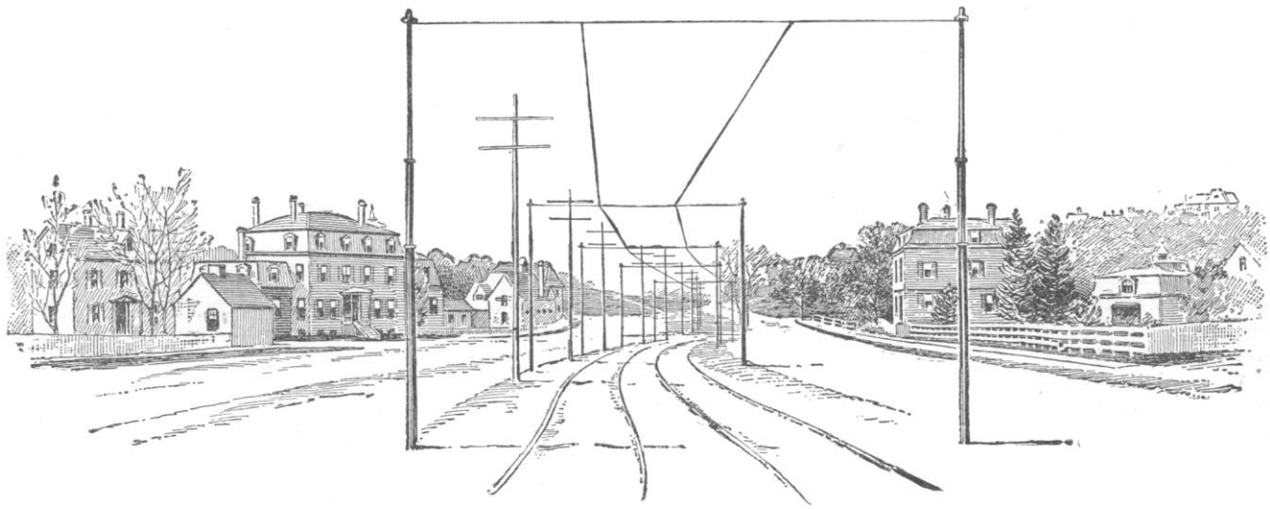
started and stopped without the use of brakes in the space of three or four inches, and, when making the normal running speed, can, in an emergency, be stopped and reversed without brakes within less than a quarter of a car length. This is especially advantageous in crowded thoroughfares, and shows the superiority of the electrical car over the horse or cable cars. The control over the car seems marvellous, for one sees little or nothing save an almost imperceptible movement of the hand of the motor-man; and the starting, although prompt, is very gradual and without shock or jar. The ordinary driver can operate one of these cars without the slightest trouble, after a very brief instruction. The saving on the operating cost of the Sprague system, owing to the superior quality of the apparatus, over an ordinary horse-car line, constitutes a no inconsiderable item. It has been found that the average cost of motive power per car a day throughout the United States — that is, for from ten to eleven hours, and trips aggregating from forty-five to fifty miles — is about four dollars, and this counts only those horses on actual duty on the road. The cost of motive power per day per car for equal mileage in Richmond is less than two dollars on the heaviest sort of grade-work, and at Boston it is estimated that even this low cost of operation will be reduced. For winter use upon this road the Sprague Company is equipping three electric 'working-cars,' furnished with snow-ploughs, brushes, ice-cutter, and salt-distributer, and each propelled by two powerful 30-horse-power motors. In front of the car is a revolving wheel which breaks up the snow-crust completely, and behind are revolving brushes which sweep the tracks clean. It is estimated that this 'working-car' will clear a street-railway track after a heavy storm more quickly than the ordinary snow-plough drawn by 12 horses.

The system of wiring which the West End management has adopted for the crowded city streets is the Bentley-Knight conduit, now in use in Allegheny City, Penn. Here the conduit is laid midway between the tracks, and is strongly bolted to the stringers and sleepers. Its cross-section is about a foot square, and its upper part has a slot similar to that used in cable-railways; its width, however, being only five-eighths of an inch, giving an opening so small that carriage-wheels will not catch in it. Besides this, it is so bevelled that horseshoe calks will not be held in it. Copper bars an inch and a quarter thick, one on each side of the slot, firmly insulated beneath it, carry the current, — one from the dynamo, and the other returning from the motors. The current is taken from the conductors to the motors by 'ploughs,' as they are called, two to each car. These ploughs are thin iron plates about ten inches square, hung from a framework over the middle of the track, and projecting into the slot. The motors are connected by controlling-switches, and the car is operated substantially as is the overhead system. The ploughs are so arranged that they can be lifted out of the slot when any obstruction is reached. The current is taken up and returned by spring-plates, which slide along the copper conductors at the bottom of the plough.

In switching, two ordinary tongue-switches are used, — one in the conduit, and one on the rail. Brushes attached to the snow-ploughs and cars easily keep the conduit and tracks clear, even in the severest snow-storm or in case of slushy and muddy weather.

The change from the overhead system to the conduit is made while the car is in motion, and without the slightest delay in travel or inconvenience to passengers; so that the Sprague cars run over the entire distance.

The kind of truck used upon this road is the latest Sprague improved truck, which has been fully described in these columns. The equipment of this truck includes the new Sprague 'Boston' motor, which will be used, for the first time in commercial work, upon this road.



BEACON STREET, WEST FROM HARVARD STREET.

MOHAMMEDANISM AND SLAVE-TRADE IN AFRICA.

THE recent events in Africa have shown the enormous power Mohammedanism exerts in that continent. The growth of the empire of the Mahdi, the foundation of states by the Fulbe, the steady progress of Mohammedanism in the Galla country, prove its vast historical importance in Africa. We have shown on the accompanying map the distribution and growth of Mohammedan power in Africa according to an interesting study by A. Oppel, published in the Journal of the Geographical Society of Berlin.

Christianity early penetrated into Egypt, and from this point spread rapidly up the Nile as far as Abyssinia, and all over the north coast of the continent. In Egypt many of its dogmas were developed under the influence of Alexandrinian philosophy, while some of the ceremonies of ancient Egyptian worship found their way into the Christian cult. Here, also, many dogmatic controversies originated, which were the cause of long-continued wars. The Christian Church in Africa disintegrated, and at the same time was degraded by assimilating numerous heathenish elements. When, therefore, Mohammedanism first entered African territory, the ancient Christianism was swept away. In 640 A.D., Omar's general, Amru Ibn al Assi, invaded Egypt, which had been a province of Byzantium, and in 641 conquered Alexandria. In order to secure his hold upon the newly conquered province, Omar settled a number of Arabian tribes in Egypt, and through their influence numerous natives adopted the Mohammedan faith. Amru next subjected the western borderland of Egypt, and his successor, in 664, conquered Fezzan. In 711 the whole of North Africa was under Arabian sway. The native Berbers as well as the descendants of the Greeks and Romans, soon adopted their faith and language.

In the sixteenth century the power of the Berbers had increased considerably, and by acknowledging the authority of a Berber caliph they became independent of the Oriental Empire. As the number of Arab immigrants was originally small, they began to be merged into the Berbers; but in the middle of the eleventh century several nomadic tribes who had lived in upper Egypt